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CENTRAL MIXING PLANTS FOR CONCRETE

By EDWARD HECK

CONCRETE has come to be one of our most used construction materials, so it is not strange that quantity production methods should be applied to its preparation. The central mixing plant idea is simply the logical outcome of large demand. The establishment of central plants for the production of ready-mixed concrete was suggested by the successful operation of similar plants for concrete highway paving. Ready mixed concrete from such plants is often hauled four or five miles with good results.

The mixer in a central plant should be able to deliver thirty cubic yards or more in an hour. Usually this requires a capacity of a not less than one cubic yard per batch. Some plants use two one cubic yard mixers, and in one plant located in Dallas a two-yard mixer is used.

For successful and profitable operation the plant must be located, designed and equipped so that it can be operated at full capacity with a minimum number of men. There must be ample trackage available for cars of sand, stone and cement, so that there would be little danger of a shut down caused by lack of materials, due to poor switching facilities. Some plants use gasoline tractors for moving the cars, and sometimes a power winch and cable is used. There must be ample equipment to unload the material rapidly and with a minimum of manual labor. The most common system is a derrick or crane equipped with a clamshell bucket. A screw or bucket conveyor system is sometimes used where the materials may be dumped directly from the cars into the storage bins. The method of unloading is of course a problem of the individual plant and must be worked out for utmost efficiency under the existing conditions.

The size of the entire operating crew, when running at full capacity, generally varies from eight to twelve men,

depending on the size and condition of the plant. In a typical plant, operated by eight men, the distribution was as follows: superintendent, one crane operator, one mixer operator, one man for feeding aggregate to bucket conveyor, one measuring aggregate at mixer, one cleaning out material cars, and two handling cement. The full crew would be required only when the plant was operating at capacity. If operating intermittently, a well designed plant could be handled by three or four men, assuming that one of them could handle the crane, hoist, or mixer as occasion demanded. Most of the plants are operated by building material dealers, and when the plant is not running to capacity the men are employed at other work about the yard.

Plants operating in the northern states should be equipped to furnish warm concrete for cold weather construction, little additional equipment being needed to heat the aggregate and water. An old boiler, unsuitable for high pressure work, but still satisfactory, to furnish steam at low pressure for the aggregate bins, can be obtained at little cost. A grillage of steam pipes perforated with one-eighth inch holes, laid about three feet above the discharge gates of bins containing the fine and coarse aggregates makes a good arrangement for heating them. The water can be heated by any one of the several schemes commonly used on construction work.

It is important that the measuring hoppers be of such design that they will insure accurate measurement of all materials used, under all conditions. It should be possible to adjust them quickly for batches of varying proportions, as a dozen jobs may be supplied in one day, each requiring a mix different from the others.

A new and very efficient way of measuring materials



Concrete Hauled from Plant One-Half Mile Away

—Courtesy Successful Methods.

is by weight. This would be impractical in portable equipment, but fits the need exactly at a central plant. Some time ago in supplying concrete for the building of a dam a Chicago contractor used a central mixing plant, which would have been ideal for the selling of ready mixed concrete. His system of measuring by weight was very interesting. A steel hopper was mounted under the aggregate bins on the frame of a dial scale. The dial was about six feet away and in plain view of the man in charge. The stone and sand dumped directly into the hopper through metal gates and the cement was fed by a screw conveyor. Three indicating markers were placed on the dial for each different proportioned mix. First the stone would be allowed to flow into the hopper until the pointer reached the first marker, then sand until the pointer reached the second mark, and finally the conveyor would be started and cement weighed in on top until the last marker was reached. When the required materials were proportioned the contents of the hopper discharged into the mixer through a gate in the bottom. This system combined wonderful simplicity and flexibility. Different proportions could be measured with no adjustment except a change of position of the markers.

With this method a complicated proportion such as 1:2.3:3.4 can be measured just as easily as the more common mixtures. For the more simple proportions even the changing of the markers could be eliminated by using sets of different colored markers to indicate different mixes, and leaving them permanently in place. A complete list of proportions with weights for each printed on a convenient card would enable the operator to deliver without delay any mix desired.

Another advantage of weighing equipment is its great accuracy. When moisture is added to dry sand it swells sometimes as much as 30%. Then if the proportioning is done by volume sometimes there is a deficiency of as much as two cubic feet of sand in one batch of concrete. Concrete deficient in sand is richer in cement than intended, and costs more per cubic yard than it should. The variation of sand content in concrete, and the errors caused by bulking can be eliminated largely if the sand is measured by weight instead of by volume. A correction for the estimated moisture content added on the scales practically eliminates errors in proportions due to bulking and moisture content of the sand. The Iowa State Highways Commission now requires that all aggregates used in state highways be measured by weight, in order to secure greater uniformity.

The plant owned by W. S. Walker in Columbus uses a novel and efficient way of measuring sand to compensate for moisture content. A large cylindrical can called an inundator is mounted on pivots so that when it is filled with sand it dumps into the mixer. A certain amount of water is placed in this inundator, depending on the moisture content of the sand. For very dry sand the container is filled about one-third full of water, and if the original sand is moist an amount of water proportionately less is used. Thus the moisture of the sand is held constant, and a given amount of sand will always occupy approximately the same volume.

In Mr. Walker's plant the aggregates are dumped directly from the cars into *under ground* bins, and carried by a bucket conveyor system to the measuring hoppers. The cement is stored in a bin above the aggregates, and carried to the mixer in a similar manner. Working at capacity the plant can turn out around 25 cubic yards of mixed concrete in an hour.

Bulk cement, which is used at most central mixing plants, has many advantages over sacked cement. It eliminates the work and expense of emptying, cleaning, bailing and shipping empty bags. It can be unloaded from

cars into bins and handled from bins to mixer by machinery to better advantage than cement in sacks. One of the most successful methods for unloading it is by means of a power scoop operated by two men with a small electric or gasoline hoist. One large user of bulk cement finds that three men can unload three cars of bulk cement per day with an outfit of this type. When the cement storage bin is below the level of the measuring hopper a belt or screw conveyor system is usually used to carry the cement from the bins to the hopper. This conveyor must be clutch operated so that the cement supply may be started quickly and stopped when the amount of cement required for a batch has been delivered to the hopper. Most storage bins for aggregate in plants now operating provide storage capacity of materials sufficient for three or four hours capacity of the mixer. Their bins are most conveniently located over the measuring hoppers so that materials may flow directly by gravity.

Perhaps the biggest problem of the central plant is delivery. Where volumes are large, the roads well paved, and the haul short, large trucks with solid tires will deliver concrete at a lower cost per ton mile than the light trucks. Where conditions are reversed the small trucks are generally found to have the advantage. Pneumatic tires under heavy loads cost more per mile of operation than solid tires, but they cause less vibration and wear of the truck mechanism and less compacting of the concrete than solid tires. Trucks on pneumatic tires can make better speed and therefore longer hauls than solid tired trucks. Some central mixing plants do not own all their trucks, but contract for the delivery of the concrete with the local trucking concerns when extra trucks are required. This relieves the plant operator of the investment in a large fleet of trucks and the responsibility of their care and operation.

A question might well arise as to the strength of this ready-mixed concrete. Builders are generally skeptical of little-tried methods. In road construction it has been common to haul concrete four or five miles without injuring its strength or ability to hold up under adverse weather conditions. Experiments and tests carried out by the bureau of public roads in 1921 showed that the strength of the concrete was not impaired when hauled for periods as great as three hours. These tests and the practical experience of large users of concrete indicate that there is no danger of injury by hauling it any economical distance, providing it is not segregated when deposited at its final position.

Field experience shows that concrete compacts into a solid mass in the truck body when it is hauled for a considerable time, and that the rapidity and degree of compacting is greater with concrete of thin consistency. If it is to be hauled more than a few blocks it should be stiff enough so that it will show a slump of not more than four inches when tested with a slump cone. When concrete has been thoroughly mixed there is less danger of segregation than in an imperfect mix. The minimum should be $1\frac{1}{2}$ minutes mixing time.

When a load of concrete is compacted in a truck body it can be dumped only with difficulty unless special means are provided to clear the body when the load is dumped. Several schemes have been used to overcome this difficulty. In one method a piece of log chain is laid across the front end of the body with the ends laid out along the bottom toward the rear. If the load does not clear itself from the truck when dumped a pull on one or both ends of the chain will usually clean the truck. There is seldom need of such equipment, however, if the concrete is mixed for at least $1\frac{1}{2}$ minutes, and has a slump within specified limits.

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Concrete should always be dumped from the truck into a batch box. Under no circumstances should delivery be made directly into the forms. Concrete of the required consistency, when placed directly into the forms, cannot be spaded or spread properly without honeycombs, and the exposing of reinforcement bars. Another feature that must be guarded against is the re-mixing of concrete on the job by adding additional water. Such a procedure will unquestionably reduce the strength of the concrete, and lead to a practice that will place the central mixing plant in disrepute.

One of the biggest problems to be faced, is that contractors usually have large investments in portable equipment. They are naturally slow to accept a new source of supply while their old machinery will serve. It will take time to wear down existing prejudices. The system is still on its mettle, but in practice it is proving itself.

All in all it appears that the central mixing plant is here to stay. It is not a theory or upstart, but the answer to the crying demand of modern industry—quantity production at the lowest cost. It combines centralization and efficiency. The men who run mixing plants are specialists in the concrete field. On the one hand we have a number of small portable mixers operated by inefficient help in many cases, and under field conditions. All materials must be handled by hand, and often piled in unprotected places. The facilities for proper proportioning are poor at the best. Upkeep and the expense of moving the machines is always high. On the other hand the central mixing plant is all that modern efficiency can ask. From the time the materials leave the car until the finished concrete reaches the job, everything is done by machinery controlled by a few skilled men.

"The proof of the pudding is in the eating." Mixing plants in many of the large cities are providing better and cheaper concrete to the users, and making profits for their owners. The predictions of the men at the head of the cement industry are slowly becoming facts.

If a man does any useful thing better than his neighbors, though he build his house in the woods, the public will make a path to his door.—*Emerson*.



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